Webinar Series on Climate Change Projection for Disaster Risk Reduction in Asia-Pacific Region: 4th Webinar with Malaysia
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Source : South China Morning Post

Impacts of Climate Change and Extreme Weather Events in Malaysia

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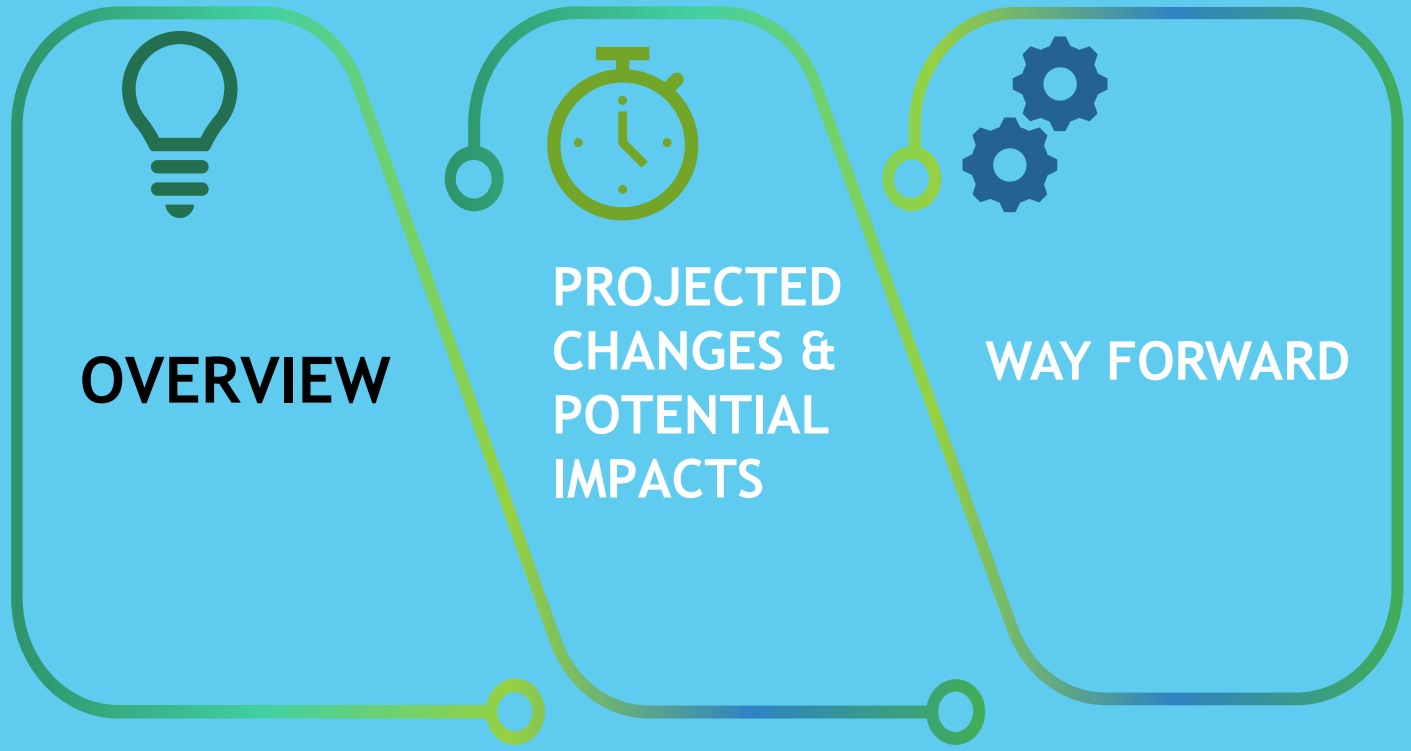
PRESENTATION OUTLINE



ESSENTIAL ISSUES of SCIENTIFIC DATA

- Accurate assessment of climate change
- Understanding environmental and societal impacts
- Modelling future scenarios
- Mitigation and adaptation strategies
- Quantifying economic and health costs
- Monitoring progress and accountability

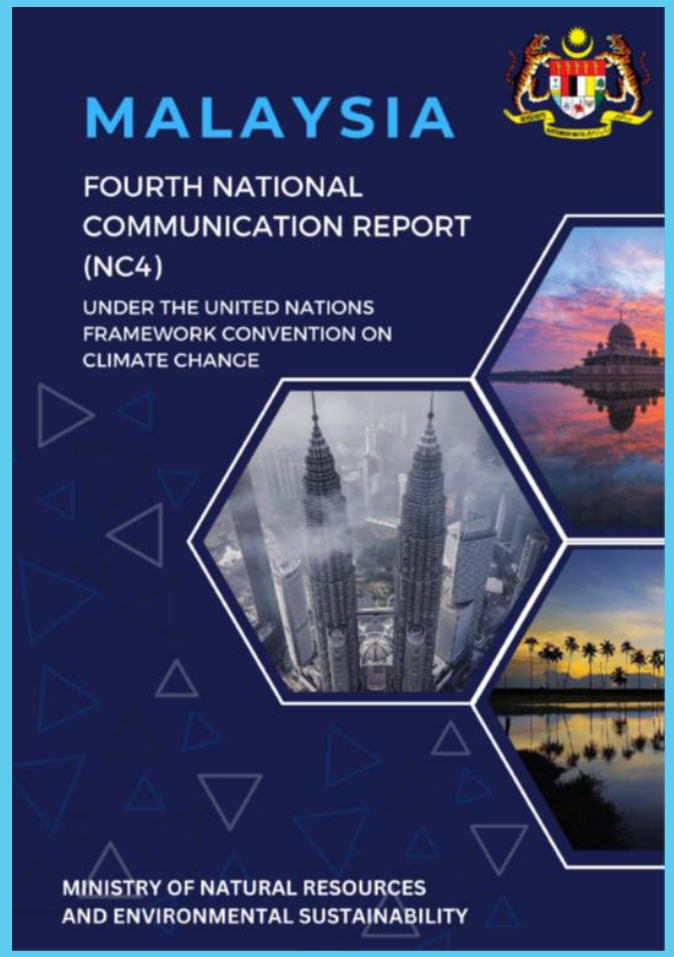
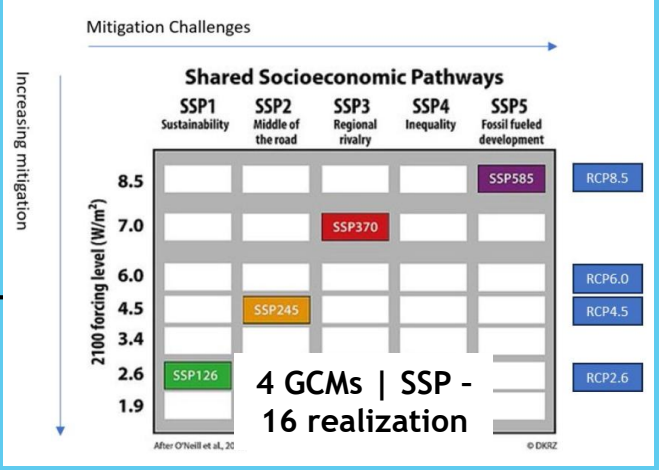


Table 4.1: Summary of Climate and SLR Projections and Their Assessments for NC3 and NC4

Item	NC3		NC4	
	PENINSULAR MALAYSIA	SABAH & SARAWAK	PENINSULAR MALAYSIA	SABAH & SARAWAK
(A) HYDROCLIMATE PROJECTION				
IPCC Assessment Report	AR4		AR5	
Number of GCMs	3	2	5	
Name of GCMs	ECHAM5 MRI-CGCM2.3.2 CCSM3	ECHAM5 MRI-CGCM2.3.2	CCSM4 MIROC5 MRI-CGCM3 GFDL-ESM2M IPSL-CM5A-LR	
Scenario	A1FI, A2, A1B, B1	A1B	RCP 2.6, 4.5, 6.0 & 8.5	
Realisations	15	4	16	
Regional Downscaling Model	RegHCM-PM	RegHCM-SS	RegHCM-PM 2.0	RegHCM-SS 2.0
Spatial Resolution	6 km	9 km	6 km	
Meteorological Parameters	Rainfall, Air Temperature		Rainfall, Air Temperature	
Time Resolution	Hourly		Hourly	
Projected Period	2010-2100		2010-2100	
ASSESSMENTS				
Flood				
Area	15 basins	Not carried out	17 basins	20 basins
Period	2030 & 2050	Not carried out	2100 (early to late-century)	2010-2054 (early to mid-century); 2055-2100 (mid to late-century)
Dry Spell				

- AR4 (2007) - Focus: Stronger evidence of human influence and impacts
- AR5 (2013/2014)- Focus: Climate Impacts, Adaptation & Mitigation strategies]

Model used | scenarios & no. of realization for hydro-climate projection



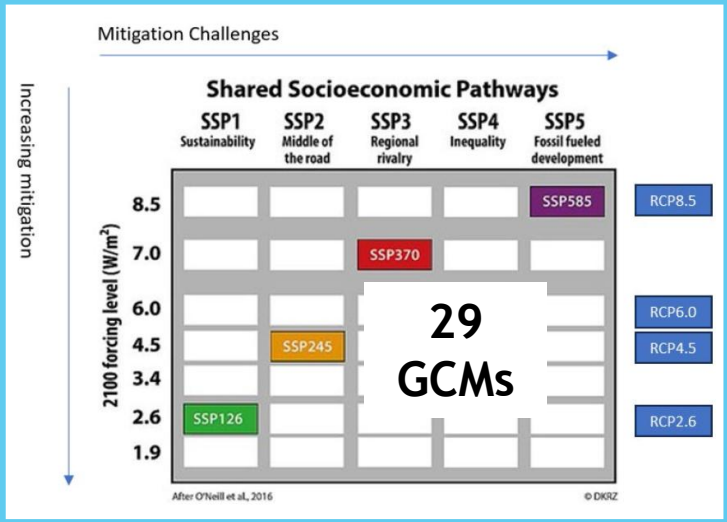
Flood assessment | 37 nos. of river basin | PM & SS

Item	NC3		NC4	
	PENINSULAR MALAYSIA	SABAH & SARAWAK	PENINSULAR MALAYSIA	SABAH & SARAWAK
Area	Whole country		Whole country	
Period	Yearly: 2010-2100		Monthly and yearly: • 2020-2046 (early-century) • 2047-2073 (mid-century) • 2074-2100 (late-century)	
Extreme Events (Dry and Wet)				
Area	Not carried out		Whole country	
Period	Not carried out		Monthly and yearly: • 2020-2046 (early-century) • 2047-2073 (mid-century) • 2074-2100 (late-century)	
(B) SEA LEVEL RISE				
IPCC Assessment Report	AR4		AR5	
Number of AOGCMs	7		29	
Name of GCMs	CGCM3.1, GISS-AOM, GISS-ER, MIROC3.2(hires), MIROC3.2(medres), ECHO-G, MRI-CGCM2.3.2a		CMIP5: ACCESS1-0, ACCESS1-3, CanESM2, CCSM4, CESM1-BGC, CESM1-CAM5, CMCC-CESM, CMCC-CMS, CNRM-CM5, CSIRO-MK3-6-0, FGOALS-g2, FIO-ESM, GFDL-CM3, GFDL-ESM2G, GFDL-ESM2M, GISS-E2-R, HadGEM2-CC, HadGEM2-ES, INMCM4, IPSL-CM5A-LR, IPSL-CM5A-MR, IPSL-CM5B-LR, MIROC5, MIROC-ESM-CHEM, MIROC-ESM, MPI-ESM-LR, MRI-CGCM3, NorESM1-ME, NorESM1-M	
Scenario	A2, A1B, B1		RCP 2.6, 4.5, 6.0 & 8.5	
Realisations	49		93	
Time Resolution	Yearly		Monthly	
Projected Period	2000-2100		2015-2100	
ASSESSMENTS				
SLR				
Area	Whole country		Whole country	
Period	2030 & 2050		2050 & 2100	
Coastal Inundation				
Area	Not carried out		Whole country	
Period	Not carried out		2050 & 2100	

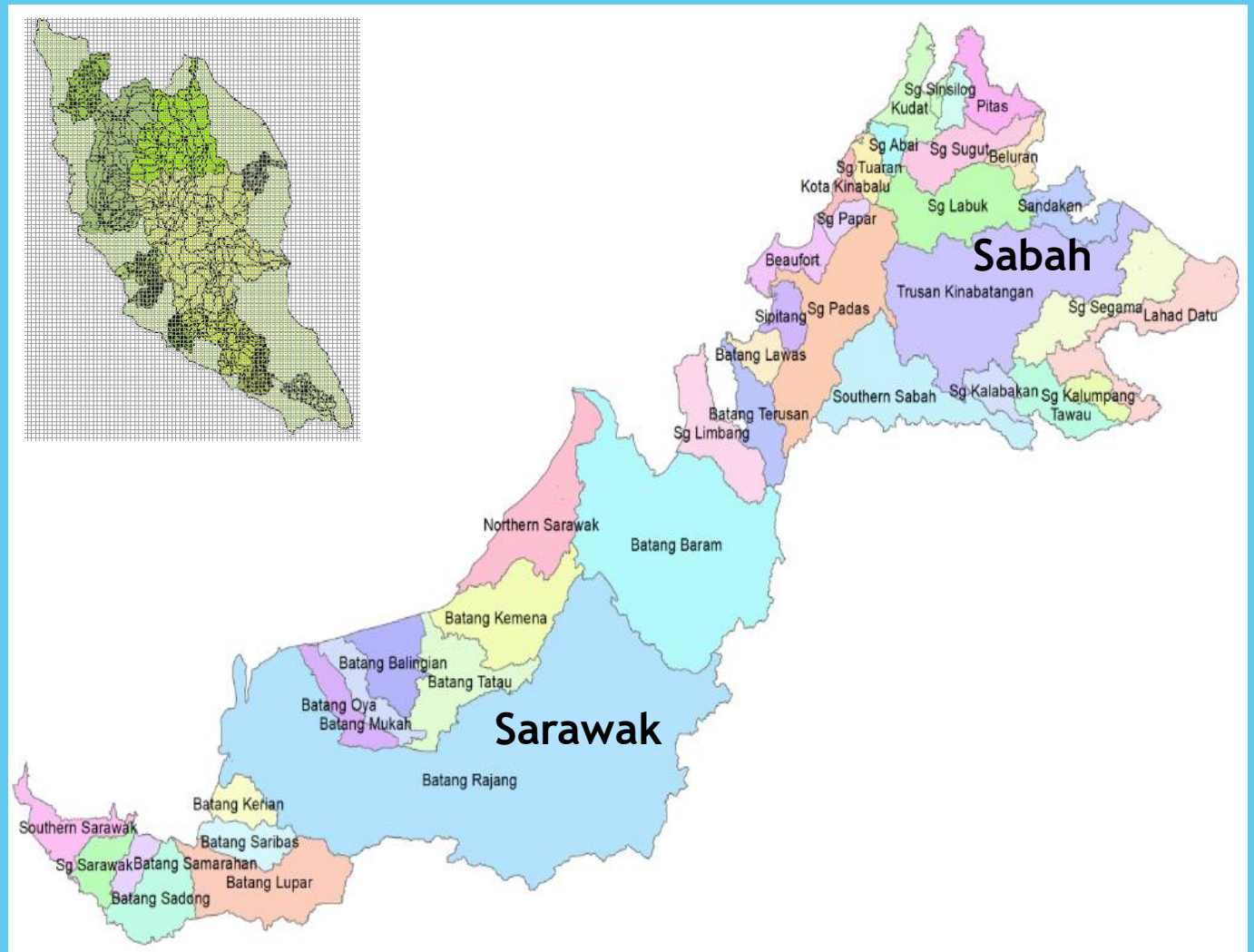
Dry spells model based scenarios

Dry period - severity | Wet Period - Severity

Model used | scenarios & no. of realization for SLR projection



SLR projection | Coastal inundation

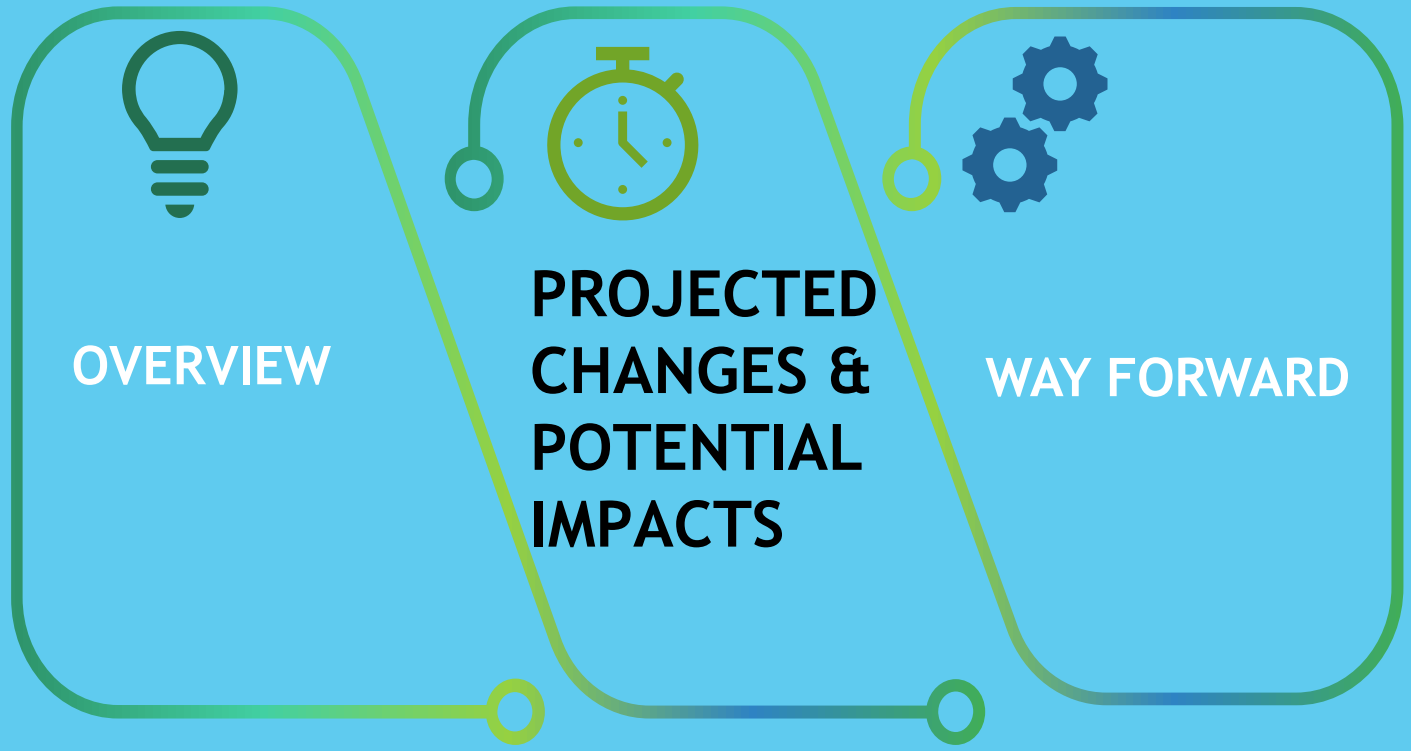


Peninsular Malaysia : 13 river basins & 12 coastal regions

Sarawak : 18 river basins & coastal / inland regions
Sabah : 21 river basins & coastal / inland regions

DYNAMICAL DOWNSCALING 6 km spatial resolution

PRESENTATION OUTLINE



	Early 21st century	Mid 21st century	Late 21st century
Mean daily average air temperature	Increase by 0.70°C - 0.77°C	Increase by 1.32°C - 1.40°C	Increase by 1.90°C - 2.00°C
Rainfall	Increase by 2.6 - 11.1%	Increase by 6.4 - 16.9%	Increase by 8.7 - 22.8%

Source: NAHRIM. 2021. The Impact of Climate Change on the Hidro-Climate of Malaysia Based on IPCC Fifth Assessment Report. National Water Research Institute of Malaysia, Ministry of Energy and Natural Resources of Malaysia (KETSA).

PROJECTED CLIMATE CHANGE

Annual Surface Temperature

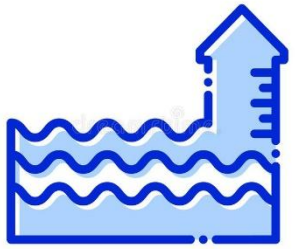
1.85 – 2.08 ˚C by 2100

• Peninsular Malaysia	[2050] 1.29-1.37˚C [2100] 1.85-1.93 ˚C
• Sarawak	[2050] 1.35-1.43˚C [2100] 1.94-2.05 ˚C
• Sabah	[2050] 1.33-1.43˚C [2100] 1.95-2.08˚C

Annual Rainfall

14% - 25% by 2100

• Peninsular Malaysia	[2050] +291mm (11%) [2100] +364mm (14%)
• Sarawak	[2050] +420mm (12%) [2100] +567mm (16%)
• Sabah	[2050] +616mm (19%) [2100] +813mm (25%)



Sea Level Rise

0.71m – 0.74m by 2100

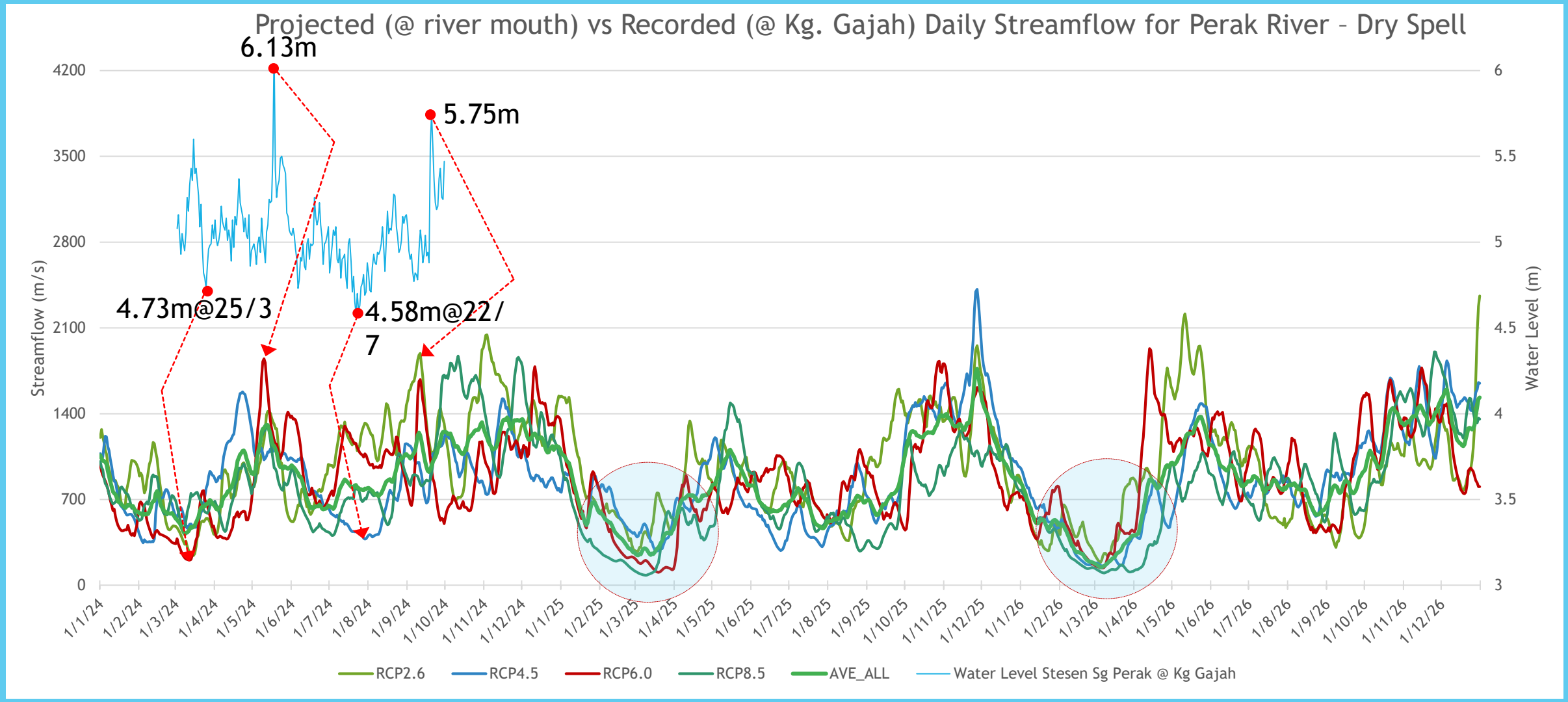
• Peninsular Malaysia	[2100] 0.71m
• Sarawak	[2100] 0.72m
• Sabah	[2100] 0.74m

Note: Based on downscaled IPCC AR5 for Malaysia (NAHRIM, 2019)

Mean annual flow for 13 selected watersheds in Peninsular Malaysia based on historical (GCM control runs) 1970-2000, and future (downscaled GCM projections) 2010-2100

No.	Basin	Historical	2010-2039	2040-2069	2070-2099	%
1.	Batu Pahat	58.0	62.0	62.5	61.2	6.7
2.	Dungun	130.3	147.9	151.5	150.9	15.2
3.	Johor	97.2	106.6	107.6	106.6	10.0
4.	Kelang	44.6	52.0	51.9	51.6	16.2
5.	Kelantan	767.2	841.9	850.3	856.6	10.7
6.	Kemaman	174.0	195.8	203.2	213.4	17.3
7.	Kuantan	131.8	149.5	151.1	150.8	14.2
8.	Linggi	41.3	44.9	45.0	44.8	8.7
9.	Muar	174.2	200.4	201.6	198.5	14.9
10.	Muda	146.1	172.3	166.4	163.3	14.5
11.	Pahang	1275.3	1402.6	1404.8	1408.7	10.2
12.	Perak	752.1	876.4	879.9	894.4	17.5
13.	Selangor	87.0	100.1	100.6	101.3	15.7

Increasing trend !


Projected (@ river mouth) vs Recorded (@ Kg. Gajah) Daily Streamflow for Perak River – Dry Spell
6.13m
5.75m
4.73m@25/3
4.58m@22/7
Streamflow (m/s)
Water Level (m)
4200
3500
2800
2100
1400
700
0
6
5.5
5
4.5
4
3.5
3
1/1/24
1/2/24
1/3/24
1/4/24
1/5/24
1/6/24
1/7/24
1/8/24
1/9/24
1/10/24
1/11/24
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1/2/26
1/3/26
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1/5/26
1/6/26
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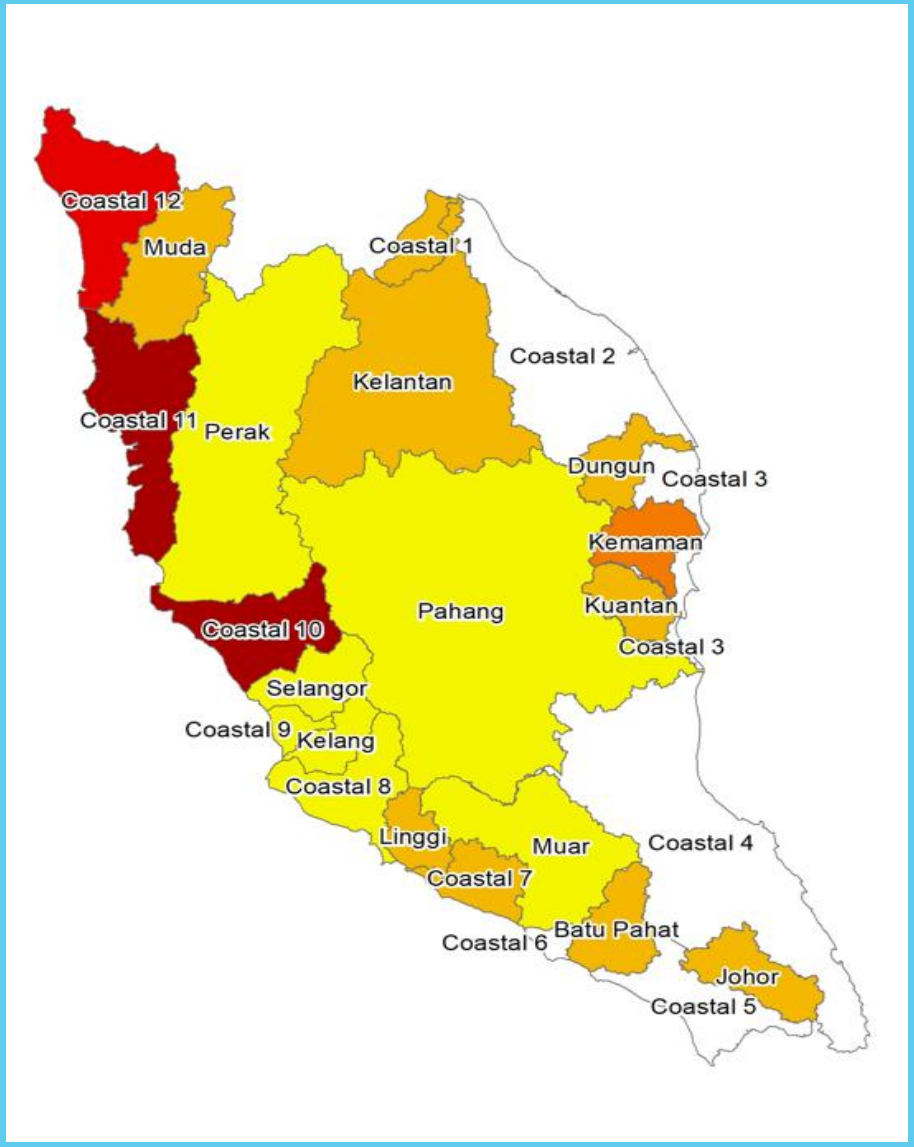
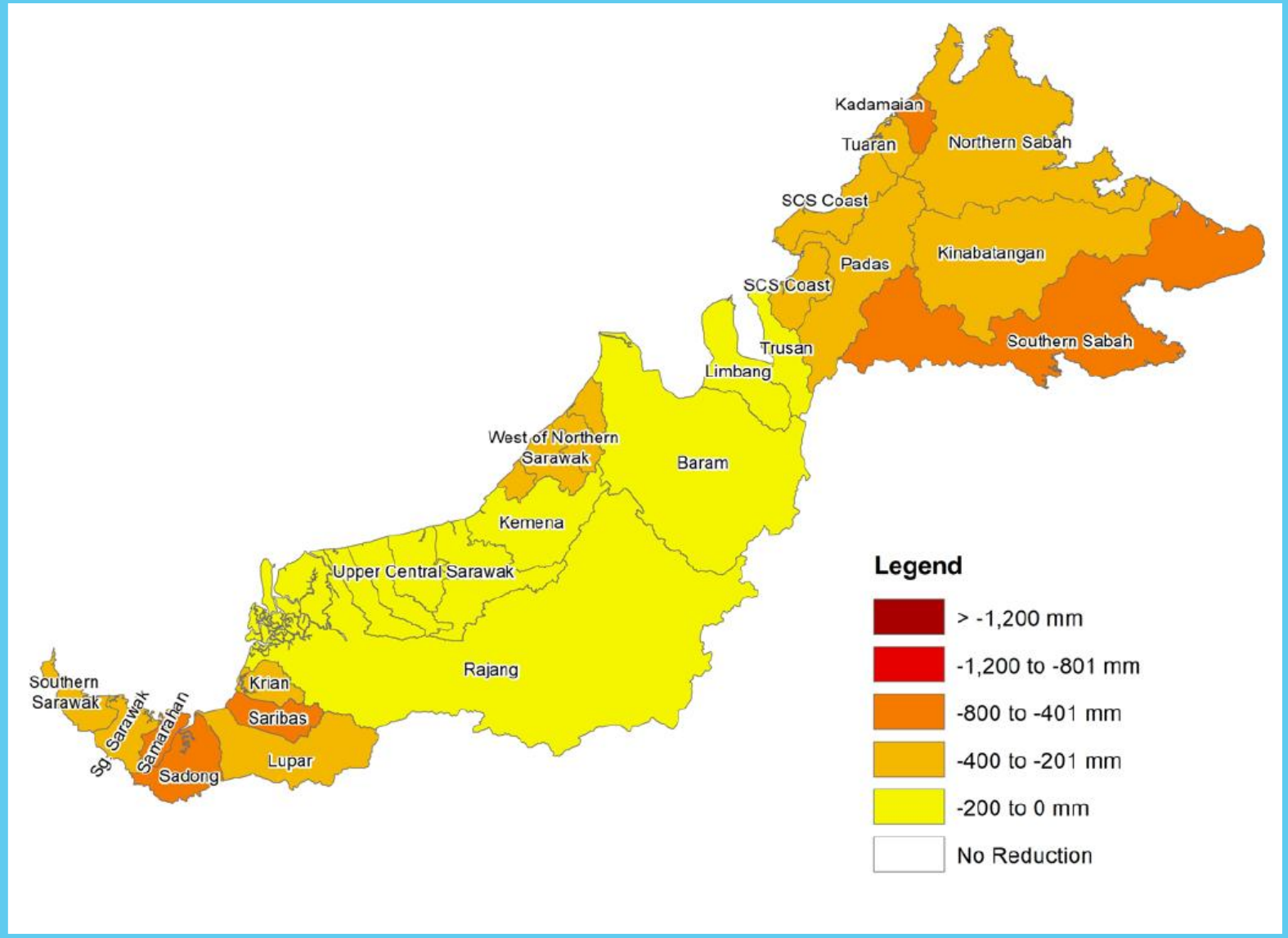
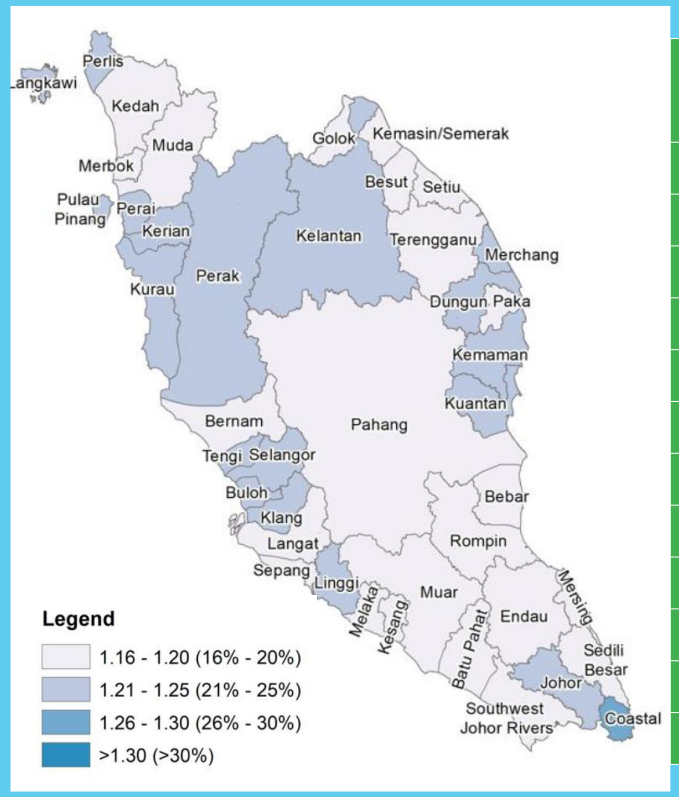
1/8/26
1/9/26
1/10/26
1/11/26
1/12/26
RCP2.6
RCP4.5
RCP6.0
RCP8.5
AVE_ALL
Water Level Stesen Sg Perak @ Kg Gajah

Projected Rainfall Reduction in PM & SS (50 yr ARI)





Changes in Rainfall Intensity



Average CCF values by grid for each state

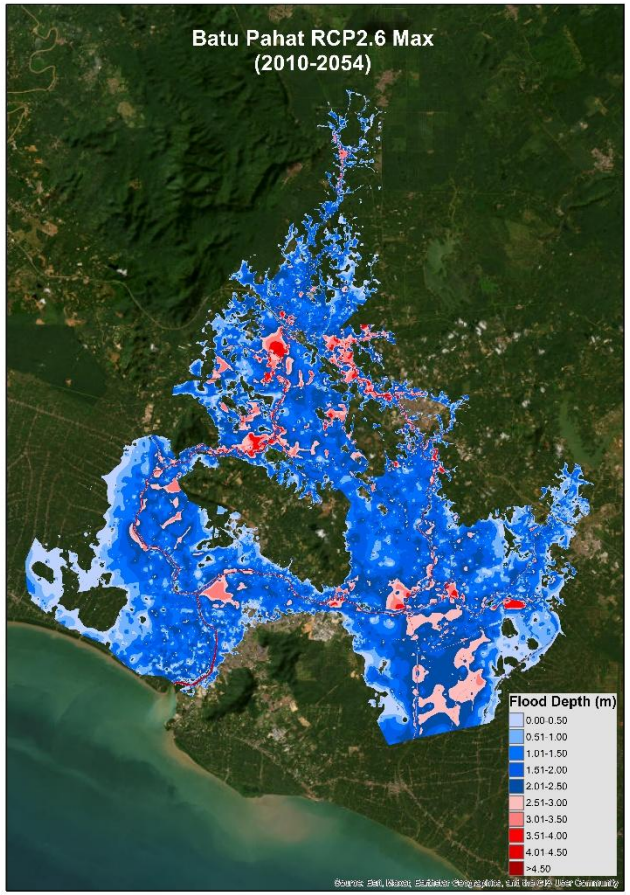
No.	State	Return Period, T						
		2	5	10	20	25	50	100
1	Johor	1.10	1.14	1.16	1.17	1.17	1.18	1.19
2	Kedah	1.11	1.15	1.16	1.18	1.18	1.19	1.20
3	Kelantan	1.13	1.17	1.18	1.19	1.20	1.20	1.21
4	Melaka	1.11	1.14	1.15	1.16	1.16	1.17	1.17
5	Negeri Sembilan	1.11	1.14	1.15	1.17	1.17	1.18	1.18
6	Pahang	1.11	1.14	1.16	1.17	1.17	1.18	1.19
7	Perak	1.13	1.17	1.19	1.20	1.21	1.22	1.22
8	Perlis	1.13	1.17	1.19	1.21	1.21	1.22	1.23
9	P. Pinang	1.12	1.18	1.20	1.22	1.23	1.24	1.24
10	Selangor	1.11	1.15	1.17	1.18	1.19	1.20	1.21
11	Terengganu	1.12	1.16	1.17	1.18	1.18	1.19	1.20
12	WP Kuala Lumpur	1.12	1.16	1.18	1.19	1.19	1.20	1.21

Average at-site CCF for 154 rainfall stations in Peninsular Malaysia

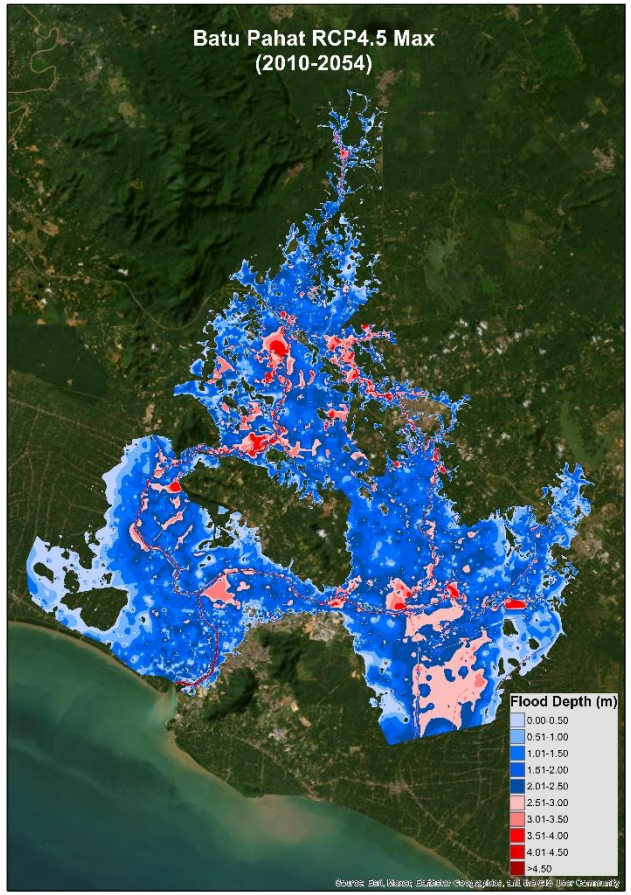
ARI	CCF	Increment rate
2	1.12	12%
5	1.15	15%
10	1.17	17%
20	1.18	18%
25	1.18	18%
50	1.19	19%
100	1.20	20%

Increment rate from 12% to 20% for return periods of 2 to 100 years in Peninsular Malaysia.

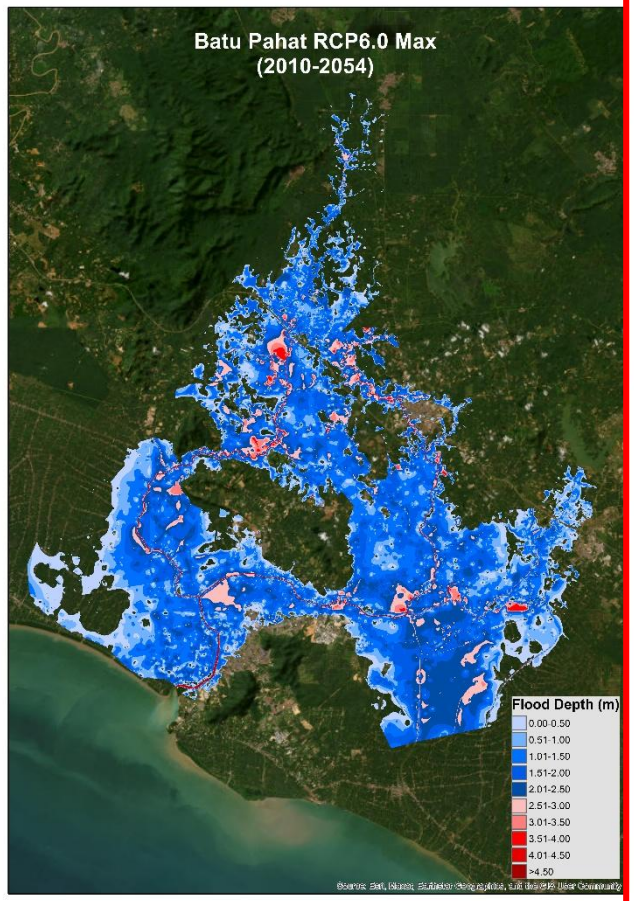
Projected Inland Flood Inundation – Batu Pahat River Basin



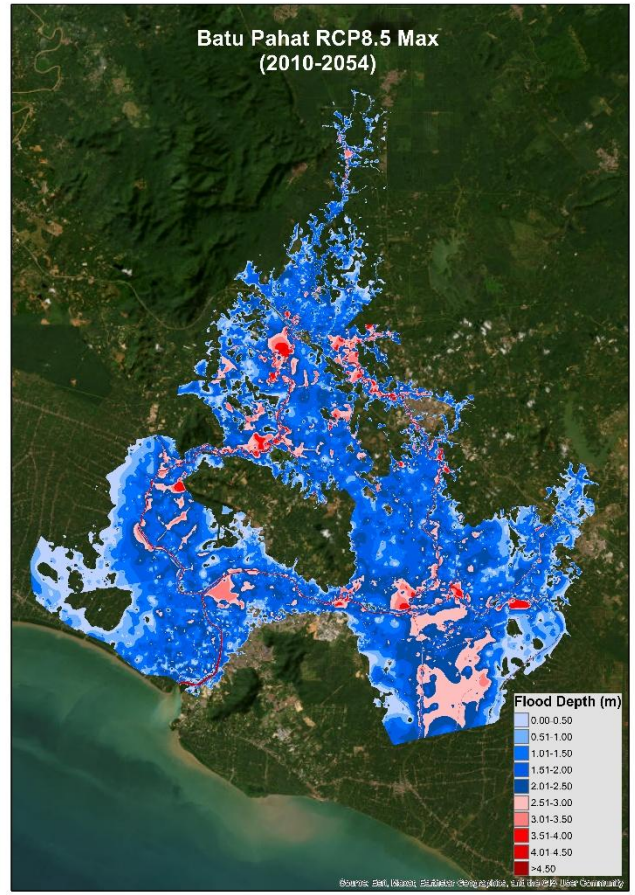
672KM²



687KM²



640KM²

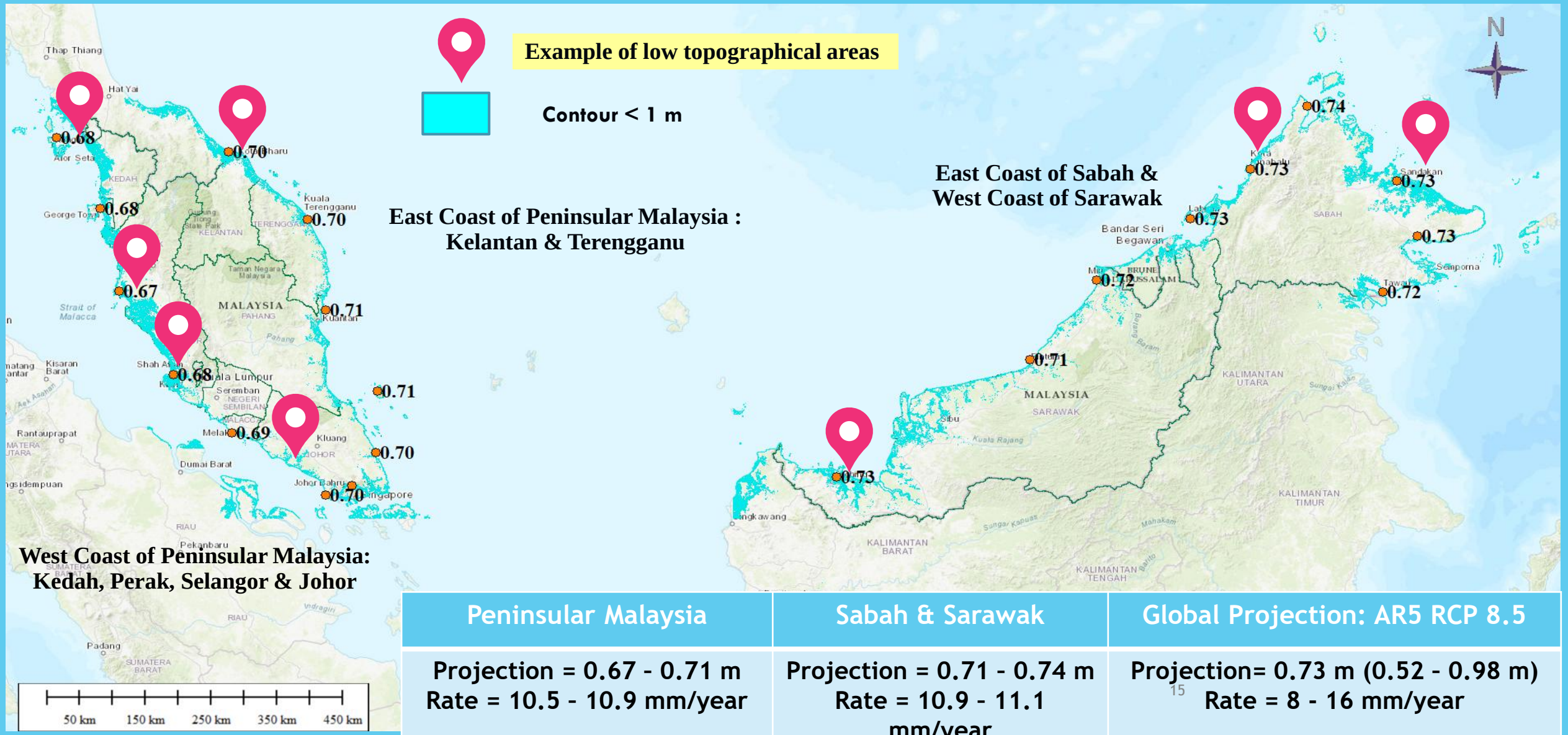


679KM²

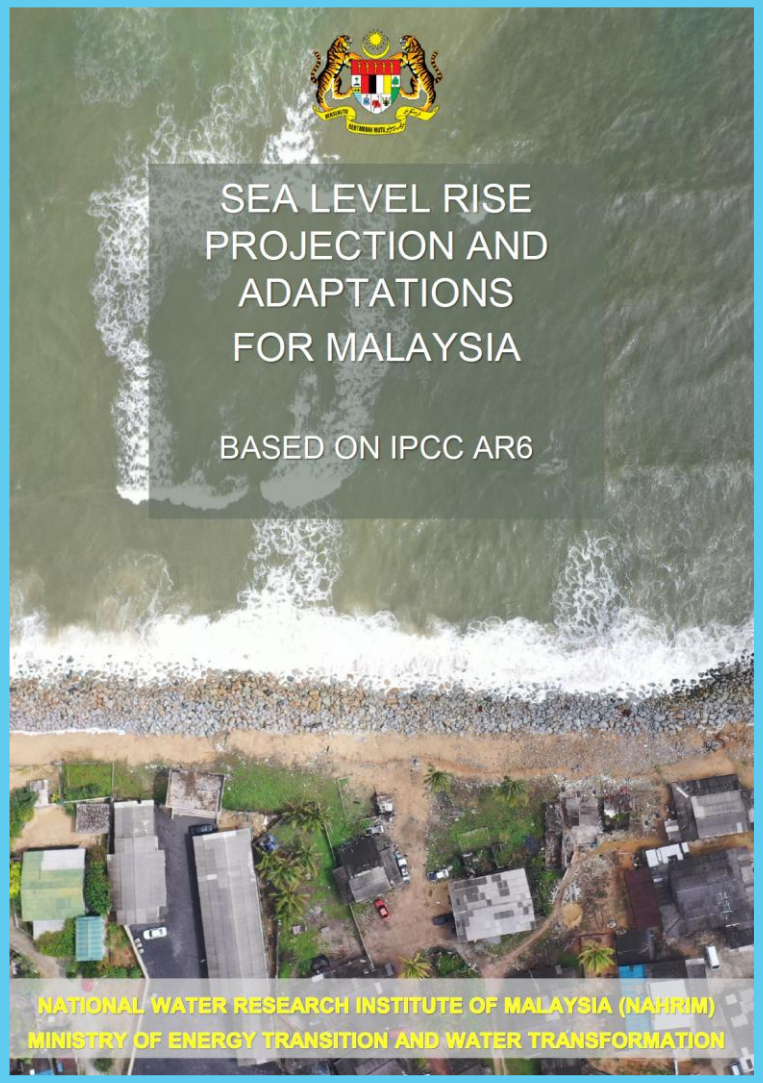
No.	Basin	Basin Area (km^2)	Single Time Slice (km^2)	2nd Time Slice (km^2)	Maximum flow (>100-year ARI) (km^2)
1.	Batu Pahat	2,232.58	296.56	652.89	690.11

14

SEA LEVEL RISE (SLR) PROJECTION BY YEAR 2100



Peninsular Malaysia	Sabah & Sarawak	Global Projection: AR5 RCP 8.5
Projection = 0.67 - 0.71 m Rate = 10.5 - 10.9 mm/year	Projection = 0.71 - 0.74 m Rate = 10.9 - 11.1 mm/year	Projection= 0.73 m (0.52 - 0.98 m) Rate = 8 - 16 mm/year



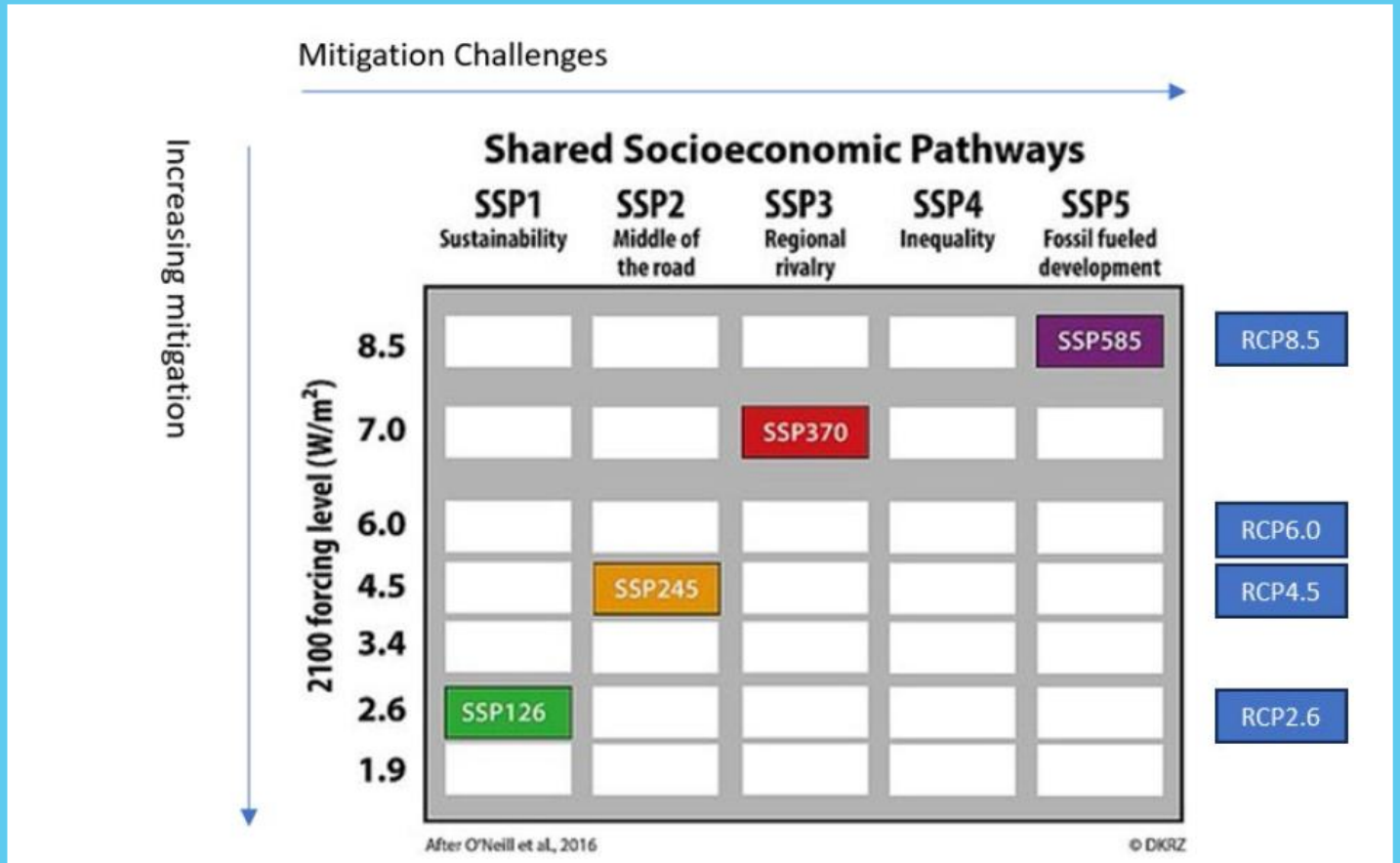
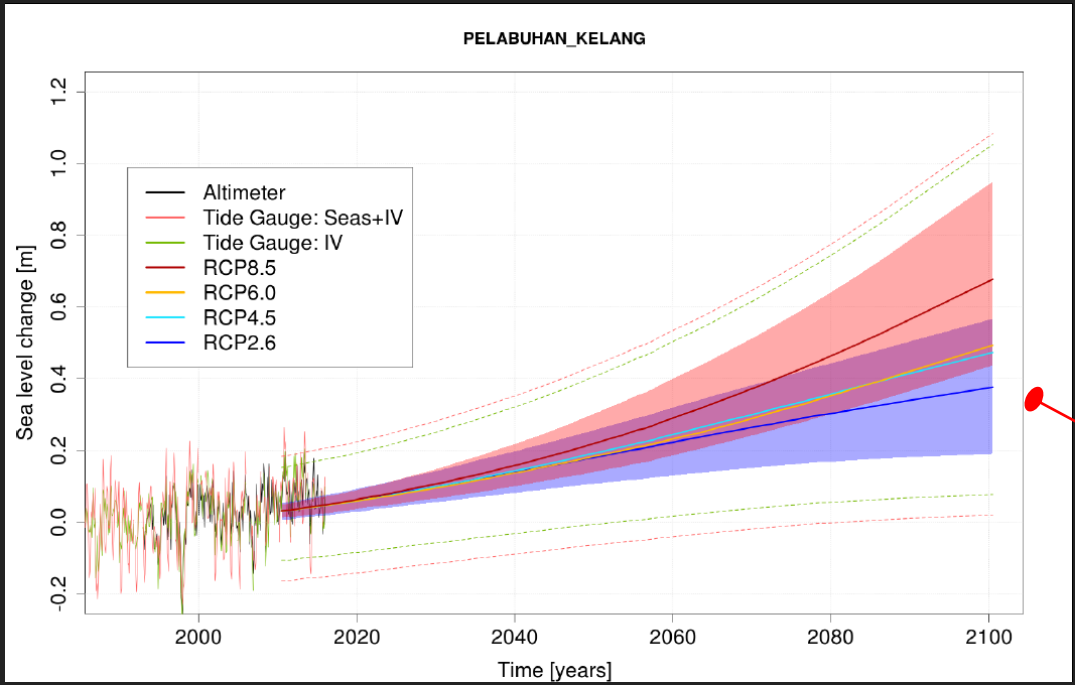
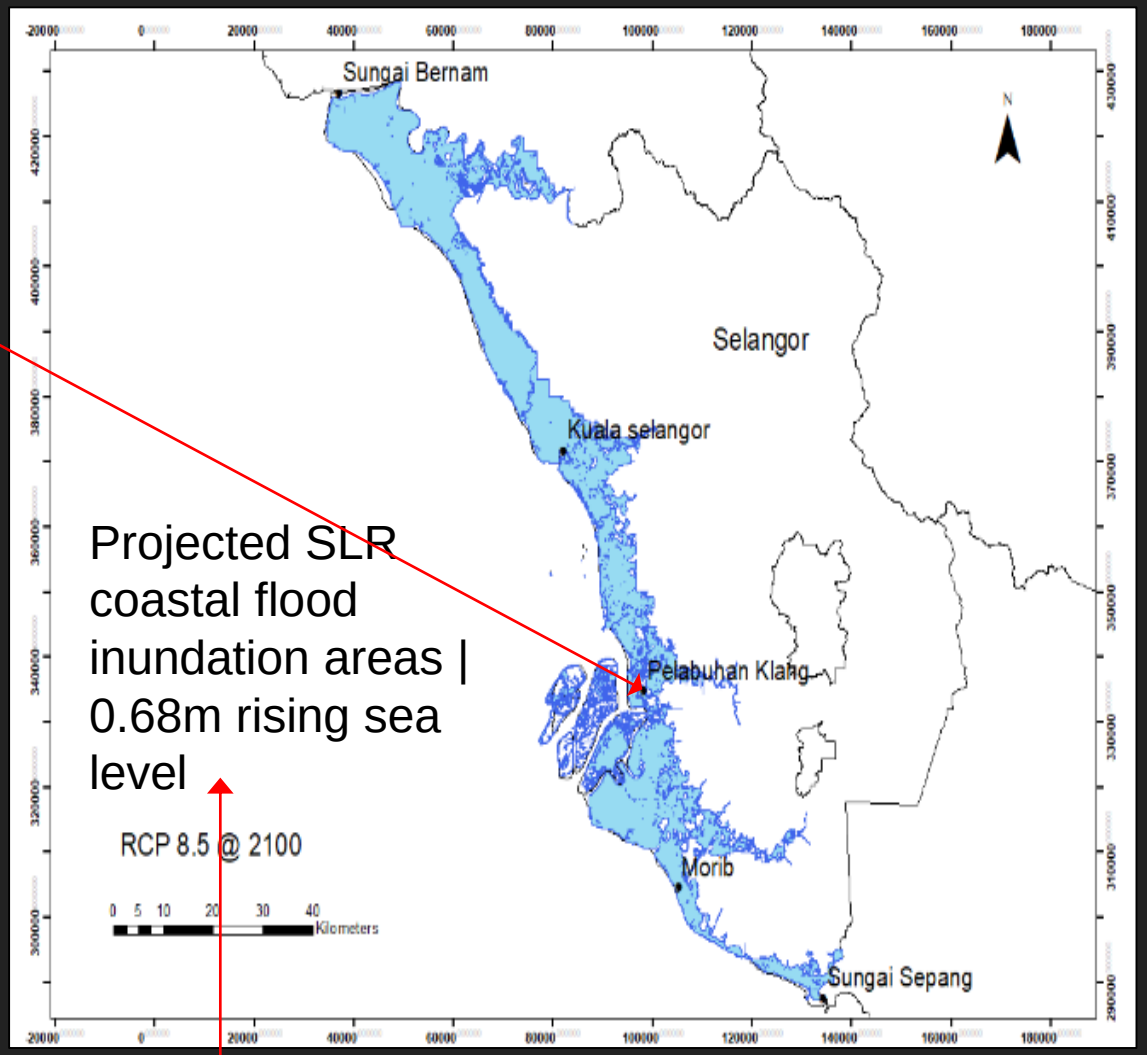


Figure 3.3 The combination of RCPs and SSPs used in CMIP6 (ScenarioMIP) (Source: O'Neill et al., 2014)

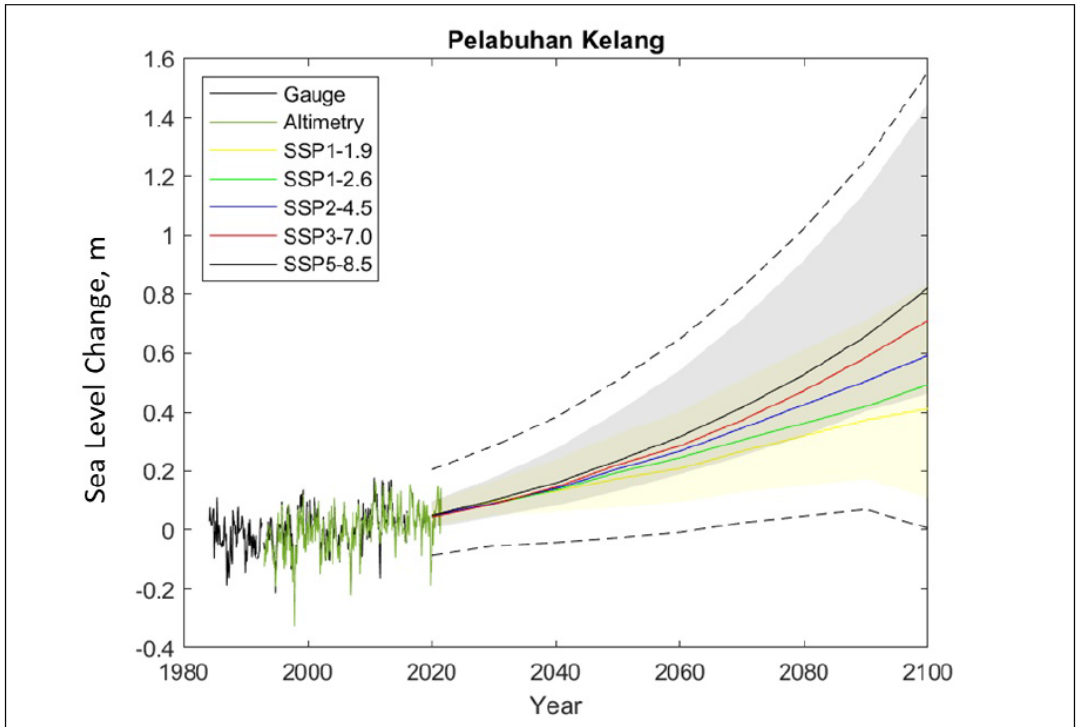
PROJECTED CHANGE OF SLR & INUNDATION



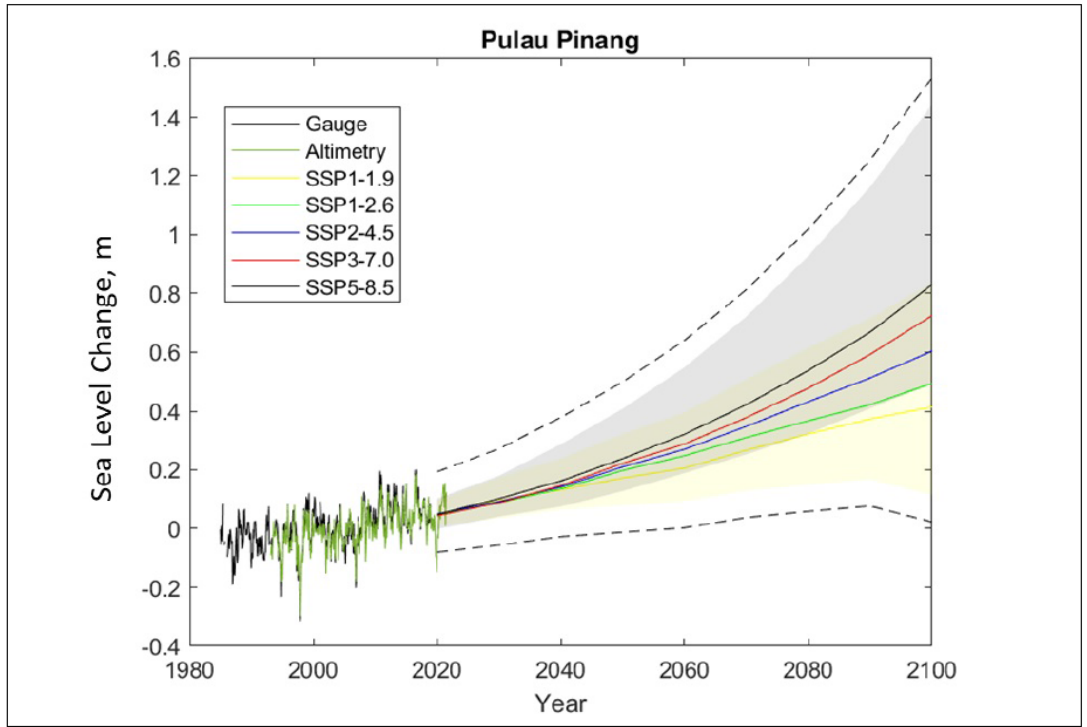
Year	RCP 2.6	RCP 4.5	RCP 6.0	RCP 8.5
2020	0.06 [0.03 - 0.10]	0.06 [0.03 - 0.09]	0.06 [0.03 - 0.09]	0.07 [0.04 - 0.09]
2030	0.10 [0.06 - 0.14]	0.10 [0.06 - 0.14]	0.10 [0.05 - 0.14]	0.11 [0.07 - 0.15]
2040	0.14 [0.08 - 0.20]	0.15 [0.09 - 0.20]	0.14 [0.08 - 0.20]	0.16 [0.10 - 0.22]
2050	0.18 [0.11 - 0.26]	0.19 [0.12 - 0.27]	0.19 [0.11 - 0.26]	0.22 [0.14 - 0.31]
2060	0.22 [0.13 - 0.32]	0.25 [0.15 - 0.35]	0.23 [0.14 - 0.33]	0.29 [0.19 - 0.41]
2070	0.27 [0.15 - 0.39]	0.30 [0.18 - 0.43]	0.29 [0.17 - 0.41]	0.38 [0.24 - 0.52]
2080	0.30 [0.17 - 0.45]	0.36 [0.22 - 0.51]	0.36 [0.21 - 0.50]	0.47 [0.30 - 0.65]
2090	0.34 [0.18 - 0.51]	0.42 [0.25 - 0.60]	0.42 [0.26 - 0.60]	0.57 [0.37 - 0.80]
2100	0.38 [0.19 - 0.57]	0.47 [0.28 - 0.68]	0.49 [0.30 - 0.70]	0.68 [0.44 - 0.95]



Projected SLR coastal flood inundation areas | 0.68m rising sea level



Year	SSP1-1.9	SSP1-2.6	SSP2-4.5	SS3-7.0	SSP5-8.5
2020	0.05 [0.02 - 0.09]	0.05 [0.01 - 0.10]	0.05 [0.01 - 0.10]	0.04 [0.01 - 0.09]	0.05 [0.01 - 0.10]
2030	0.10 [0.05 - 0.17]	0.09 [0.03 - 0.17]	0.09 [0.04 - 0.16]	0.09 [0.03 - 0.17]	0.10 [0.05 - 0.18]
2040	0.13 [0.06 - 0.24]	0.14 [0.06 - 0.25]	0.14 [0.07 - 0.25]	0.15 [0.06 - 0.26]	0.16 [0.08 - 0.28]
2050	0.18 [0.08 - 0.33]	0.20 [0.10 - 0.35]	0.21 [0.11 - 0.36]	0.22 [0.13 - 0.38]	0.24 [0.13 - 0.40]
2060	0.21 [0.10 - 0.40]	0.25 [0.12 - 0.45]	0.27 [0.15 - 0.48]	0.29 [0.16 - 0.50]	0.32 [0.19 - 0.54]
2070	0.27 [0.13 - 0.51]	0.31 [0.16 - 0.56]	0.35 [0.19 - 0.61]	0.37 [0.21 - 0.65]	0.42 [0.25 - 0.72]
2080	0.32 [0.15 - 0.61]	0.36 [0.19 - 0.67]	0.43 [0.24 - 0.76]	0.47 [0.27 - 0.83]	0.53 [0.32 - 0.92]
2090	0.37 [0.17 - 0.71]	0.42 [0.21 - 0.79]	0.51 [0.28 - 0.91]	0.59 [0.35 - 1.03]	0.66 [0.40 - 1.15]
2100	0.41 [0.11 - 0.84]	0.49 [0.20 - 0.95]	0.59 [0.28 - 1.10]	0.71 [0.38 - 1.27]	0.82 [0.46 - 1.45]
	Average rate of sea level rise (mm/year) change				
2081-2100	2.67 [-1.83 - 8.43]	4.97 [-0.73 - 12.23]	7.13 [1.77 - 15.1]	9.6 [3.8 - 18.67]	11.57 [5.13 - 22.63]

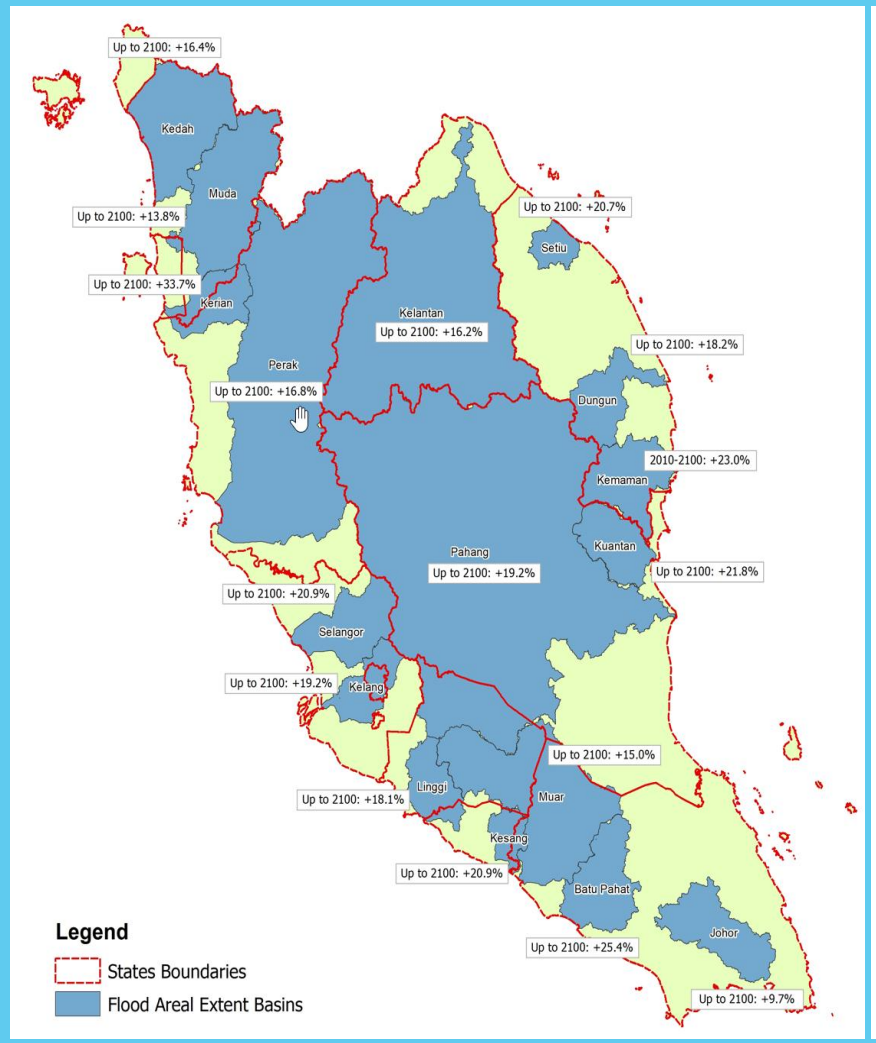


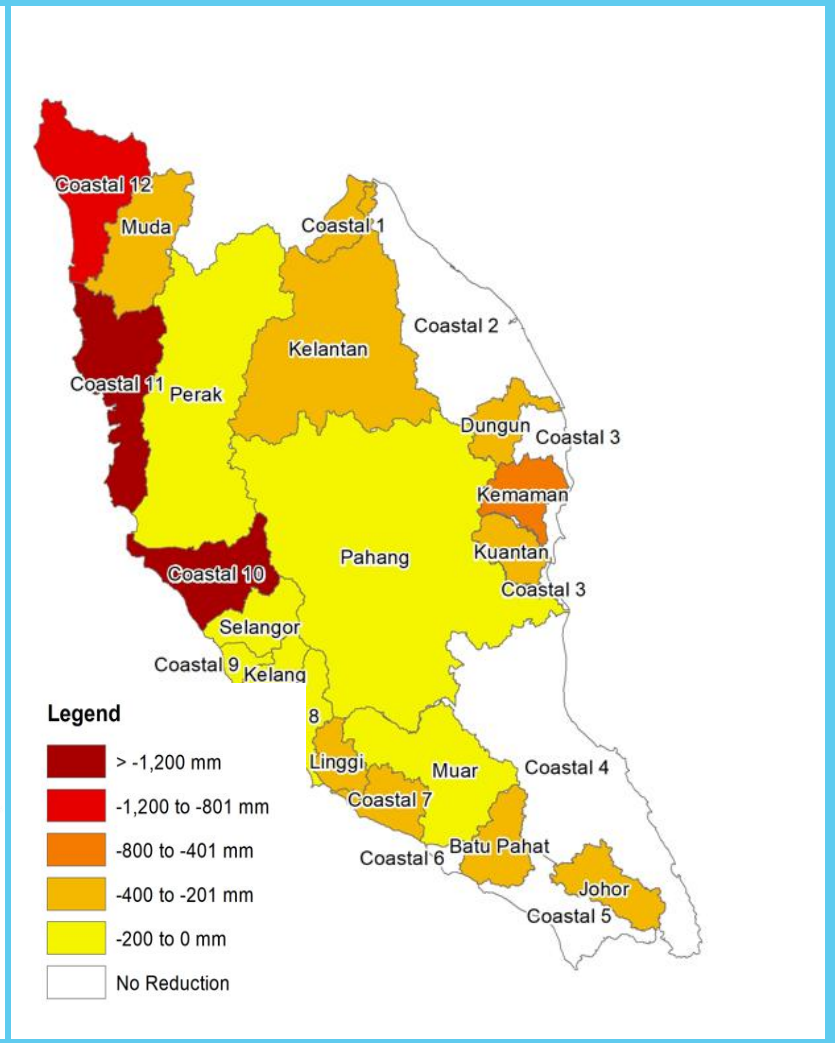
Year	SSP1-1.9	SSP1-2.6	SSP2-4.5	SS3-7.0	SSP5-8.5
2020	0.05 [0.01 - 0.10]	0.05 [0.00 - 0.11]	0.05 [0.00 - 0.10]	0.04 [-0.01 - 0.10]	0.05 [0.00 - 0.10]
2030	0.10 [0.04 - 0.18]	0.09 [0.02 - 0.18]	0.09 [0.03 - 0.17]	0.09 [0.02 - 0.17]	0.10 [0.04 - 0.18]
2040	0.13 [0.06 - 0.24]	0.14 [0.04 - 0.26]	0.14 [0.06 - 0.26]	0.15 [0.06 - 0.27]	0.16 [0.08 - 0.29]
2050	0.17 [0.08 - 0.32]	0.20 [0.09 - 0.36]	0.21 [0.11 - 0.37]	0.22 [0.12 - 0.38]	0.24 [0.13 - 0.41]
2060	0.21 [0.09 - 0.40]	0.25 [0.12 - 0.45]	0.27 [0.14 - 0.48]	0.29 [0.15 - 0.51]	0.32 [0.19 - 0.55]
2070	0.27 [0.13 - 0.51]	0.31 [0.16 - 0.56]	0.35 [0.19 - 0.62]	0.38 [0.21 - 0.66]	0.42 [0.25 - 0.72]
2080	0.32 [0.15 - 0.62]	0.37 [0.19 - 0.68]	0.43 [0.24 - 0.76]	0.48 [0.27 - 0.83]	0.54 [0.32 - 0.93]
2090	0.37 [0.17 - 0.72]	0.42 [0.21 - 0.79]	0.51 [0.28 - 0.92]	0.59 [0.34 - 1.04]	0.67 [0.41 - 1.16]
2100	0.41 [0.11 - 0.84]	0.49 [0.20 - 0.94]	0.60 [0.29 - 1.11]	0.73 [0.39 - 1.28]	0.83 [0.49 - 1.44]
	Average rate of sea level rise (mm/year) change				
2081-2100	2.8 [-1.4 - 8.53]	5.17 [-1.1 - 12.93]	7.33 [2.00 - 15.27]	9.73 [3.7 - 18.9]	11.93 [5.33 - 23.13]

		RCP2.6/SSP1-2.6	RCP4.5/SSP2-4.5	RCP8.5/SSP5-8.5
Pelabuhan Kelang	NAHRIM (2019)	0.38 [0.19 - 0.57]	0.47 [0.28 - 0.68]	0.68 [0.44 - 0.95]
	Current report	0.49 [0.20 - 0.95]	0.59 [0.28 - 1.10]	0.82 [0.46 - 1.45]

		RCP2.6/SSP1-2.6	RCP4.5/SSP2-4.5	RCP8.5/SSP5-8.5
Pulau Pinang	NAHRIM (2019)	0.39 [0.20 - 0.58]	0.48 [0.28 - 0.69]	0.68 [0.43 - 0.95]
	Current report	0.49 [0.20 - 0.94]	0.60 [0.29 - 1.11]	0.83 [0.49 - 1.44]

Climate related Risk & Hazard - Inland & Coastal Flooding and Dry Spell



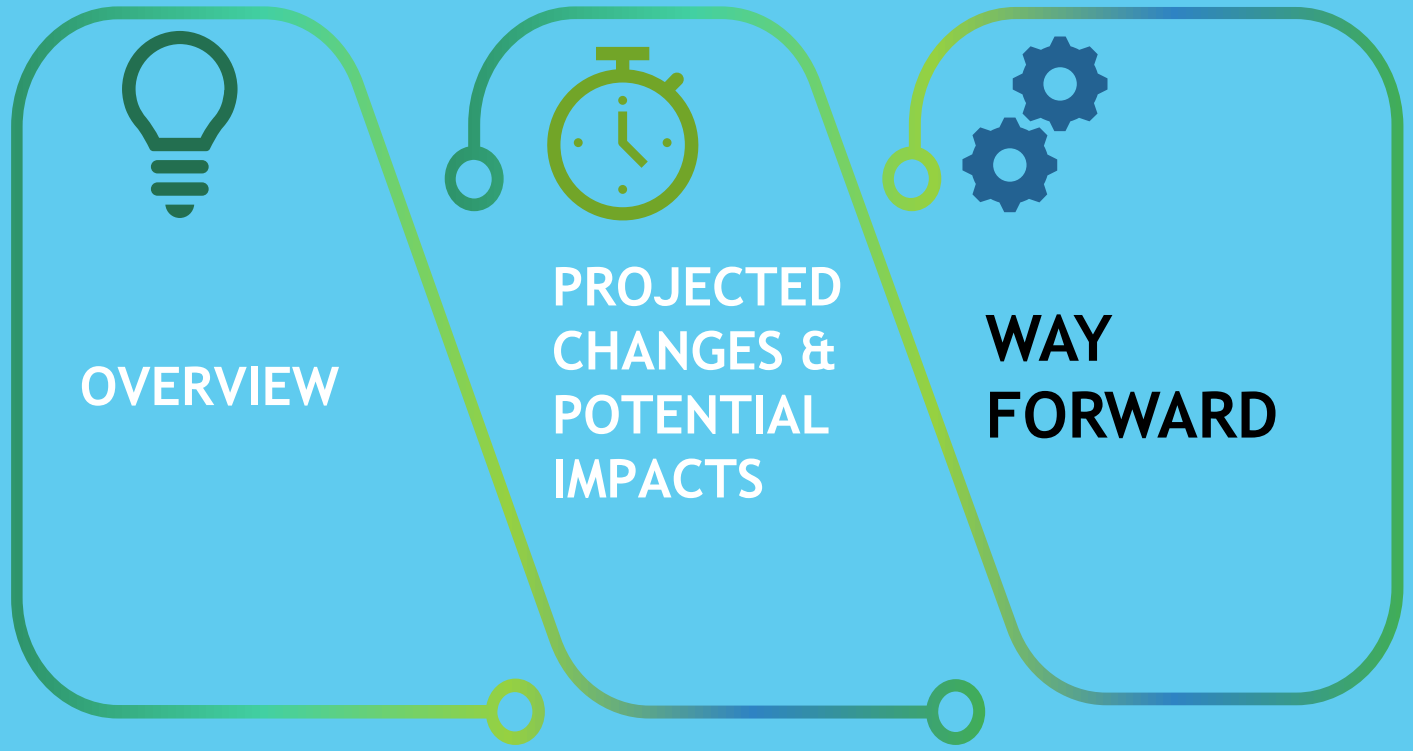


Inland flooding projected to increase by 18.2%

Dry spell – projected annual rainfall reduction up to 21-22%

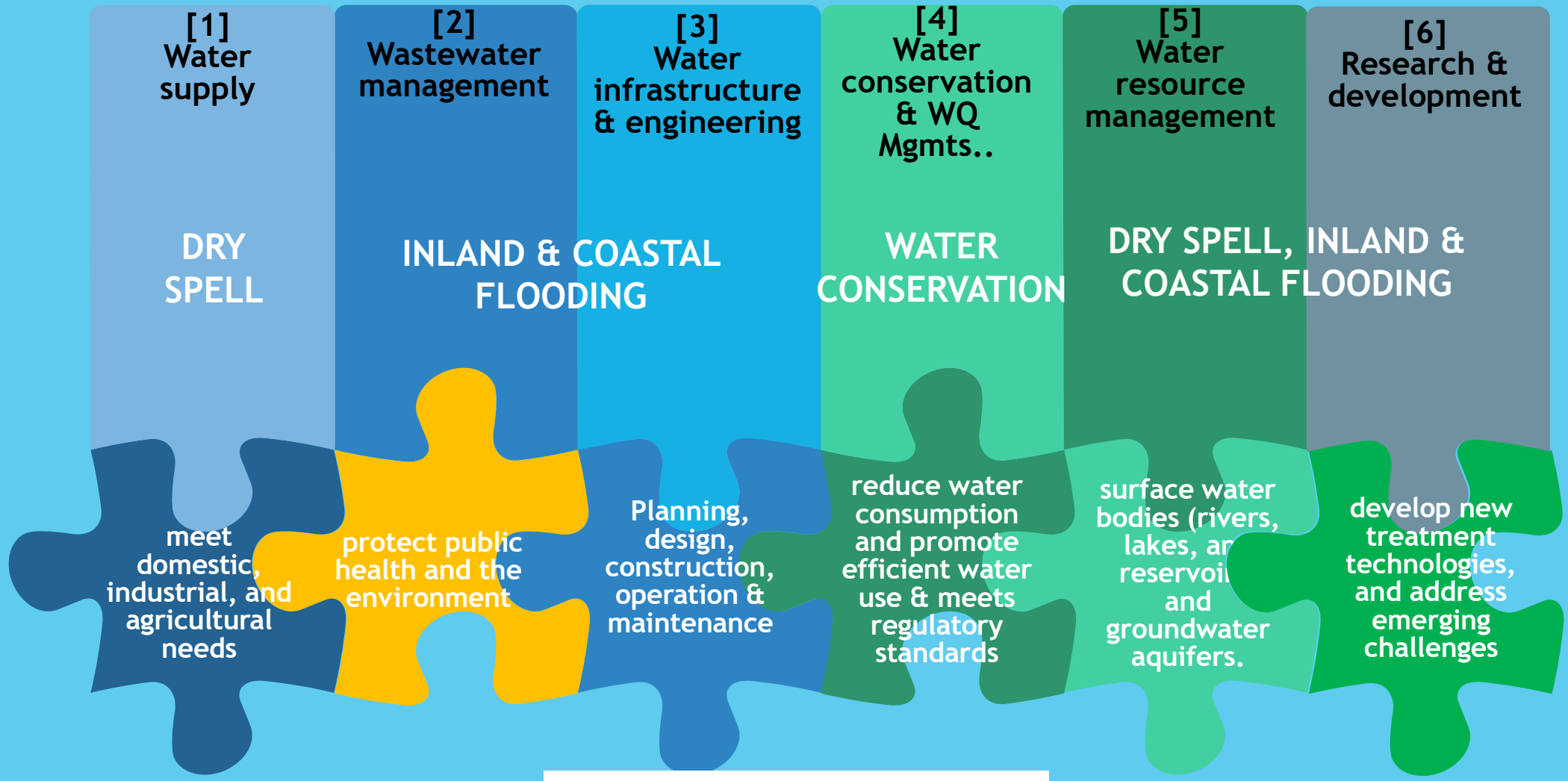
Coastal flooding – potential total inundated area will increase by 76.9% by 2100 (RCP8.5)

PRESENTATION OUTLINE



CLIMATE RESILIENCE DEVELOPMENT

some aspects in which climate change resilience for water sector



Enhancing Resilience Development – Floods, Dry Spell (Drought) & SLR

[1] Increase efficiency & technology
management, plant, asset, operation, new emerging technology

[2] Review design standards & building code
for floods, droughts & coastal risk management incorporating **climate change factor**;

[3] Review water system
management & plans and assess integrity of existing structures

…managing risks and reducing vulnerabilities…

[4] Upgrade existing water infrastructure and management practices

[5] Improve surface /subsurface/ underground water storage :

- Off river storage
- Store seasonal high runoff / floods excess
- increase recharging groundwater recharge
- underground storage

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Way Forward

- Establish the Climate Change Act (2025) - expected to be tabled in Parliament in 3rd / 4th quarter 2025
- Malaysia's National Adaptation Plan (MyNAP) - will be commenced in the 2nd / 3rd quarter of 2025.
- Water Sector Transformation 2040 (AIR 2040) – launched in Oct. 2024, consists of 8 main components including Climate Change Impact & Adaptation (CCIA)
- Obligation to the Paris Agreement – 3rd Nationally Determined Contribution (NDC3.0) will be submitted to UNFCCC in Nov/Dec 2025.